Chapter 4

SITE DEVELOPMENT + LAND USE

401 GENERAL

KEY REQUIREMENTS

- ✓ Inventory and assess all natural resources and existing, baseline conditions on site.
- ✓ Include assessment in construction documents with the following:
  - How soils will support vegetation
  - Invasive plant species to be removed
  - Native plant species on site

TIMING IN CONSTRUCTION PROCESS

DESIGN	Complete a site inventory including a soil management plan, identifying existing invasive plant species, and native plant species.
PERMITTING	Provide site or landscape plan with locations and types of native plants, invasive plants and soil areas to be amended, including locations of cut and fill.
INSPECTIONS	Verify plan submitted is executed at foundation, rough in and final inspections
CERTIFICATE OF OCCUPANCY	===
POST OCCUPANCY	Site maintenance plan should be created and worked into a building maintenance plan schedule.

RATIONALE, BENEFITS, AND INTENTIONS

The National Park Service (NPS) estimates that nearly 25% of the 20,000 native plant species in North America are at risk of extinction due to the threat of invasive non-native organisms. Invasive plants disrupt natural ecosystems, and displace native plant and animal species and other biological resources. Preservation of individual native species requires preservation of entire plant communities, including those not yet in danger of extinction, because of the interdependency of the ecosystem as a whole. Native plants are valued for their economic, ecological, genetic, and aesthetic benefits, in addition to the growing societal belief in their intrinsic value as aboriginal species.

The provisions of the Green Code are intended to reduce the threat of invasive non-native plants and to return native plants to the landscaping. A number of the multifaceted benefits to the retention of native plants identified by the NPS are applicable in the District:[1]

- add beauty to the landscape
- serve as food and habitat for native wildlife
- decrease use of water for irrigation
- reduce landscape maintenance if planted and established properly
- establish root systems to prevent soil erosion
- protect water quality by controlling soil erosion and moderating floods and droughts

BEST PRACTICES AND INNOVATIONS

Develop a comprehensive soil protection and restoration plan following the IgCC Section 405.1.1[2] in conjunction with the District's Stormwater Management and Soil Erosion and Sediment Control regulations.

A soils map, site plan, or grading plan that indicates designated soil management areas for all site soils should be developed, including but not limited to:

1.1. Soils that will be retained in place and designated as vegetation and soil protection areas (VSPAs).

1.2. Topsoils that will be stockpiled for future reuse and the locations for the stockpiles.

1.3. Soils that will be disturbed during construction and plans to restore disturbed soils and underlying subsoils to soil reference conditions.

1.4. Soils that will be restored and re-vegetated.

1.5. Soils disturbed by previous development that will be restored in place and re-vegetated.

1.6. Locations for all laydown and storage areas, parking areas, haul roads and construction vehicle access, temporary utilities and construction trailer locations.

1.7. Treatment details for each zone of soil that will be restored, including the type, source and expected volume of materials, including compost amendments, mulch and topsoil.

1.8. A narrative of the measures to be taken to ensure that areas not to be disturbed and areas of restored soils are protected from compaction by vehicle traffic or storage, erosion, and contamination until project completion.

A written erosion, sedimentation and pollutant control program for construction activities associated with the project. The program shall describe to accomplish the following objectives:

2.1. Prevent loss of soil during construction due to stormwater runoff or wind erosion, including the protection of topsoil by stockpiling for reuse.

2.2. Prevent sedimentation of stormwater conveyances or receiving waters or other public infrastructure.

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[1] Dorner, Jeanette. "An introduction to using native plants." EPA, n.d.

[2] International Code Council, Inc. *2012 IGCC: Code and commentary.* International Code Council, Inc., 2012.

2.3. Prevent polluting the air with dust and particulate matter.

2.4. Prevent runoff and infiltration of other pollutants from construction site, including, but not limited to thermal pollution, concrete wash, fuels, solvents, and hazardous chemical runoff, pH and pavement sealants. Ensure proper disposal of pollutants.

2.5. Protect from construction activities the designated vegetation and soil protection areas, flood hazard areas and other areas of vegetation that will remain onsite.

A written periodic maintenance protocol for landscaping and stormwater management systems, including, but not limited to:

3.1. A schedule for periodic watering of new planting that reflects different water needs during the establishment phase of new plantings as well as after establishment. Where development of the building site changed the amount of water reaching the preserved natural resource areas, include appropriate measures for maintaining the natural areas.

3.2. A schedule for the use of fertilizers appropriate to the plants species, local climate and the pre-establishment and post-establishment needs of the installed landscaping. Nonorganic fertilizers shall be discontinued following plant establishment.

3.3. A requirement for a visual inspection of the site after major precipitation events to evaluate systems performance and site impacts.

3.4. A schedule of maintenance activities of the stormwater management system including, but not limited to, cleaning of gutters, downspouts, inlets and outlets, removal of sediments from pretreatment sedimentation pits and wet detention ponds, vacuum sweeping followed by highpressure hosing at porous pavement and removal of litter and debris.

3.5. A schedule of maintenance activities for landscaped areas including, but not limited to, the removal of dead or unhealthy vegetation; reseeding of turf areas; mowing of grass to a height which optimizes lawn health and retention of precipitation.

Field studies should be conducted by qualified biologists, landscape architects, or other certified professionals who will assess the current condition of the project area, conduct a botanical survey, and review pertinent studies of the project area.

Evaluate information from the Maryland Native Plant Society, Washington, D.C. Chapter, and the District Department of the Environment, Department of Agriculture Plants Database for the potential for special-status species to occur in the project area.

The National Park Service provides comprehensive guidance in restoring a site with native plants, from the planning stages through maintenance, in *An introduction to using native plants in restoration projects,* at: http://www.nps.gov/plants/restore/pubs/intronatplant/toc.htm.

Restoring the site with native and adaptive vegetation may be eligible for electives in Appendix A, Section A104.5 and Table A104.

CASE STUDY

WASHINGTON, DC: ROCK CREEK CONSERVANCY[3]

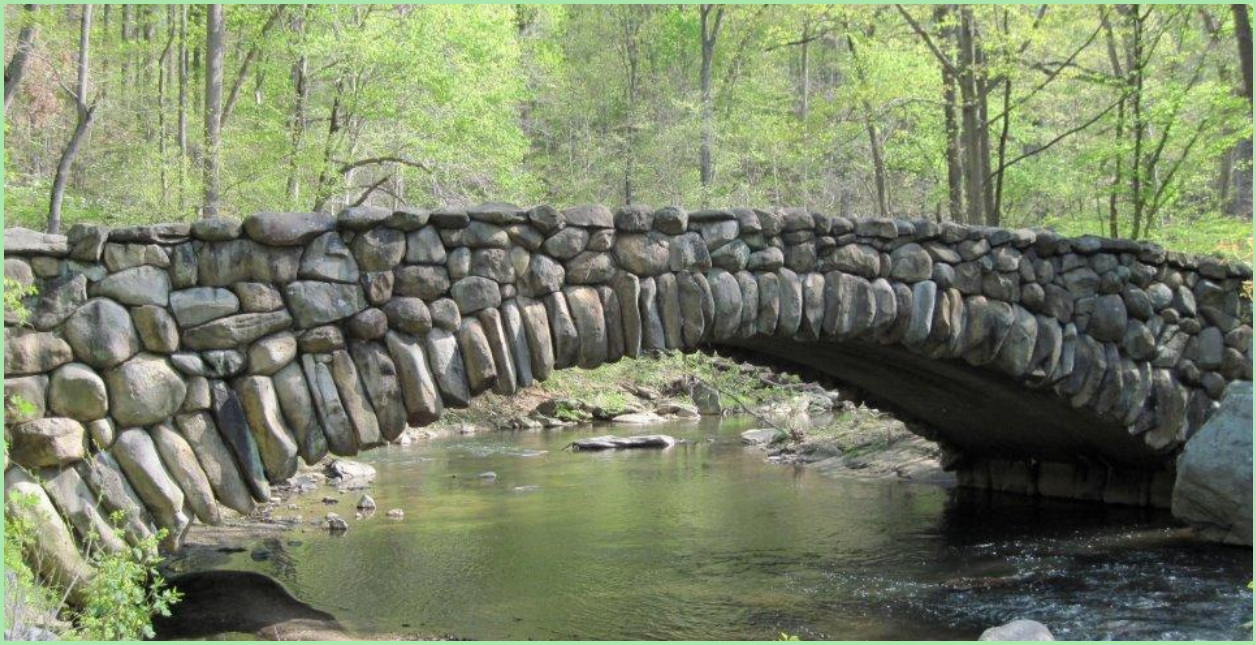

Image http://www.rockcreekconservancy.org/

Context: Rock Creek is affected by runoff from surrounding neighborhoods. The creek suffers from trash, polluted runoff, sewage overflows, loss of trees, destruction of fish and wildlife habitat, and an influx of invasive non-native vegetation.

Project Description: In partnership with the District Department of the Environment, Rock Creek Conservancy has worked to showcase eco-friendly landscaping practices that help reduce the volume of polluted runoff entering the waterways. Rock Creek Conservancy assisted in spearhead the RiverSmart Homes program by installing a demonstration garden in each of the eight District wards, and is presently working with the Department of the Environment and other partners to measure the efficacy of green techniques in runoff reduction in two Rock Creek neighborhoods.

Results: Illustrating the multi-faceted benefits of native plants in the District, Rock Creek Conservancy has organized well over 100 stream-cleanups in parks along the Creek. Over 50 teams keep an eye out for problems in the creek and organize their neighbors for projects such as trash cleanups, tree planting, weeding of invasive plants, and storm drain marking. Rock Creek Conservancy was the winner of the District of Columbia 2011 Mayor's Environmental Excellence Award, and was named the 2011 District of Columbia Nonprofit Partner of the Year.

[3]DC Department of Energy. *Case Study - Rock Creek Conservancy*. n.d. http://green.dc.gov/service/case-study-rock-creek-conservancy (accessed 08, 27, 2013)

RELATED CODES AND STANDARDS

Stormwater Management and Soil Erosion and Sediment Control. District of Columbia, July 19, 2013.

http://ddoe.dc.gov/page/2013-rule-stormwater-management-and-soil-erosion-and-sediment-control

RESOURCES

District Department of the Environment

http://ddoe.dc.gov/service/natural-environment

Maryland Native Plant Society, Washington, D.C. Chapter

http://www.mdflora.org/chapters/washingtondc/dcchapter.html

Mid-Atlantic Invasive Plant Council

http://www.maipc.org

National Park Service

http://www.nps.gov/index.htm

Native and Drought Tolerant Landscaping: Metro DC Lawn and Garden Blog, Ladybird Johnson Wildflower Center

http://gardening.mwcog.org/p/beneficial-drought-tolerant-plants-for.html

United States Department of Agriculture Plants Database

http://plants.usda.gov/java/

402 PRESERVATION OF NATURAL RESOURCES

Intentionally Blank. The District's Green Construction Code Supplement of 2013 deleted this section.

RELATED CODES AND REFRENCED STANDARDS

Flood Hazard Rules, Chapter 31 of 20 DCMR Environment

403 STORMWATER MANAGEMENT

Intentionally Blank. The District's Green Construction Code Supplement of 2013 deleted this section.

RELATED CODES AND REFRENCED STANDARDS

2013 District of Columbia Plumbing Code Supplement—Section 1115 Rainwater Collection and Distribution Systems

http://dcra.dc.gov/page/regulations-dcra

Stormwater Management and Soil Erosion and Sediment Control. District of Columbia, July 19, 2013.

http://ddoe.dc.gov/swregs

RESOURCES

United States Environmental Protection Agency: Stormwater Pollution Prevention Plans for Construction Activities

http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Pollution-Prevention-Plans-for-Construction-Activities.cfm

404 LANDSCAPE IRRIGATION

Intentionally Blank. The District's Green Construction Code Supplement of 2013 deleted this section.

405 MANAGEMENT OF VEGETATION, SOILS + EROSION CONTROL

KEY REQUIREMENTS

- ✓ Soils appropriate for reuse and restoration must be prepared, amended and placed to restore ability to support vegetation
- ✓ Disturbed soils that will be reused must be restored to address compaction, infiltration rates, biological functions, and soil chemical characteristics
- ✓ Documentation must be maintained, including receipts and product information, to demonstrate that proper soil restoration has occurred
- ✓ Invasive plants must be removed from the site, and no invasive plants can be planted
- ✓ New landscaping must be at least 50% native plant species

TIMING IN CONSTRUCTION PROCESS

DESIGN

405.1.4 Write into contracts requirements for soil restoration. Define reference soil for the site. Test site for areas in need of restoration.

405.1.4.1 Identify areas on site where scarification is prohibited including areas of existing tree routes, inaccessible slopes, drainage installations, brownfields, and areas where scarification would damage existing structures, utilities or vegetation to be preserved.

405.1.4.1 (1) Define reference soil including organic level depth. Research mature, stable compost to restore the top soil that meets ASTM D 2974.

405.1.4.1 (2) Determine which three of the four methods listed below the project will follow to comply:

405.1.4.1 (2) (1) Test for soil compaction with soil cone penetrometer and report results for existing root areas on site. For existing areas with densities greater than allowed, develop plan to amend soils without irreparably damaging plant life.

405.1.4.1 (2) (2) Determine reference soil infiltration rate in accordance with ASTM D 3385 or 5093. For areas with infiltration rates not matching the reference soil, develop plan to amend soils.

405.1.4.1 (2) (3)

405.1.4.1 (2) (4) Define reference soil including pH, cation exchange capacity, and nutrient profiles. Determine salinity suitable for regional vegetation. For

areas with chemical characteristics not matching the reference soil, develop plan to amend soils.

405.2 Include in site inventory locations of and types of invasive species. Develop management plan for containment and removal of plants under the reference of a published guideline or qualified professional.

405.3 Define species and locations for existing and new planting.

PERMITTING

405.1.4 Indicate on plans where soil restoration will be necessary to bring site to level of the reference soil.

405.1.4.1 Indicate in plans areas where soils will be stockpiled onsite. Note requirements of creating an area clear of debris. Create site plan that shows routes of main construction activity and avoids prohibited areas. Note requirement of construction-compacted soil to be scarified, and mixing scarified soils with new soils.

405.1.4.1 (1) Specify vegetated areas shall have at least 6" top soil containing at least 3% organic matter verified with ASTM D 2974 calculation method.

405.1.4.1 (2) Clearly identify the three code sections being followed on the site, civil or landscape plan addressing soil restoration:

405.1.4.1 (2) (1) Note areas of tests on plans with results.

405.1.4.1 (2) (2) Note areas of tests on plans with results. Include sloped areas where infiltration rate test will not apply. Provide code modification request to use alternate infiltration rate tests in these areas.

405.1.4.1 (2) (3)

405.1.4.1 (2) (4) Include on plans areas where soils need to be restored to match reference chemical characteristics. Include notes on how to amend soils in field to match the reference soil profile.

405.2 Include on plans locations of invasive plants and notes for containment or removal, including which published guide or qualified professional will be used to complete plan.

405.3 Include landscape plan with plant schedule in permit set.

INSPECTIONS

Visual verifications will occur at foundation, rough-in and final inspections for:

405.1.4.1 (1) Verify locations and several points to test for minimum 6" depth or other depth as indicated on plans.

	405.2 Collect documentation of containment and removal of invasive species (see 406). 405.3 Verify planting plan and schedule are reflective of site.
CERTIFICATE OF OCCUPANCY	===
	If due to planting seasons, 405.3 cannot be verified at the time of final inspection, a follow up inspection will be scheduled for not more than 180 days after issuance of certificate of occupancy to verify planting plan and schedule are reflective of site.
POST OCCUPANCY	Potable water used in establishment of new landscaping should be eliminated when landscaping is established. Site maintenance plan should be created and worked into a building maintenance plan schedule, including landscape maintenance plans with specifications to maintain and replace all species on site.

RATIONALE, BENEFITS, AND INTENTIONS

Section 405 establishes requirements for managing vegetation and soils and maintaining erosion control. Requirements of this section take a three-pronged approach to restoring native plants and healthy soils: soil restoration, removal of invasive plants, and planting native species.

As noted in Section 401 in regard to the requirements for a site inventory, The National Park Service (NPS) estimates nearly 25% of the 20,000 native plant species in North America are at risk of extinction, and that to preserve individual species, their plant communities must be preserved. This extends to the preservation of native plants that are not yet in danger of extinction, but still play an important role in native ecosystems. Native plants are valued for their economic, ecological, genetic, and aesthetic benefits, in addition to the growing societal belief in their intrinsic value as living species.

Healthy soils support the growth of native plants and allow rainwater to penetrate, which prevents excess runoff, sedimentation, erosion, and flooding. Soils also help clean, store, and recharge groundwater. By storing water and slowing the delivery of water to plants, healthy soils play a significant role in vegetation health.[4]

Sediment runoff rates from construction sites can be up to 20 times greater than agricultural sediment loss rates, and 1,000-2,000 greater than those of forested lands.[5]

BEST PRACTICES AND INNOVATIONS

A more involved process to manage building site waste includes pre-construction planning, soil management

[4]The Sustainable Sites Initiative. *Soils*. n.d. http://www.sustainablesites.org/soils/ (accessed October 27, 2013).

[5] EPA. "Stormwater Phase II Final Rule. Construction Site Runoff Control Minimum Control Measure." EPA, National Pollutant Discharge Elimination System. 2000. http://www.epa.gov/npdes/pubs/fact2-6.pdf (accessed 2013).

during construction, and landscape, habitat, or garden creation. The following best practices are based on the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[6]:

Pre-construction planning:

- Schedule a soil resource survey to be conducted by a qualified soil scientist or practitioner (e.g. a member of the Soil Scientist Society of America).
- Incorporate the results of the soil resource survey into the site working strategy (e.g. Site Waste Management Plan, landscaping plans, etc.), ensuring liaison between the soil resource survey and other ground investigations.
- Identify invasive plants on site to eliminate.
- Consider the use of sustainable on site drainage systems that provide more long-term protection of soils by facilitating the infiltration and attenuation of surface water.

Soil management during construction:

- Prepare a Soil Resource Plan showing:
    - areas and type of topsoil and subsoil to be stripped
    - haul routes
    - methods to be used
    - location, type, and management of each soil stockpile.
- When stripping, stockpiling, or placing soil, do so in the driest possible conditions, and use tracked equipment to reduce compaction.
- Confine traffic movement to designated routes.
- Keep soil storage periods as short as possible.
- Clearly define stockpiles of different soil materials.

Landscape, habitat, or garden creation:

- Ensure that the entire soil profile is in a condition to promote sufficient aeration, drainage, and root growth.
- Safeguard and utilize on-site soil resources where possible. If importing soils use a reputable supplier, establish the source of the soil and ensure it is suitable for the intended use.

Careful soils control during construction will maintain valuable topsoil on site for use with new landscaping, reduce pollution into District waterways via run-off, and reduce compaction typically associated with large construction projects. Maintaining topsoil and limiting compaction will allow the soil to better absorb water and establish root systems for newly installed plantings.

[6]DEFRA. "Construction Code of Practice for the Sustainable Use of Soils on Construction Sites." Department for Environment, Food and Rural Affairs, September 2009.

CASE STUDY

WASHINGTON, DC: AU SCHOOL OF INTERNATIONAL SERVICE[7]

Image http://www.sustainablesites.org/certified-sites/americanuniversity

Context: An impervious 1.8 acre lot

Project Description: The School of International Service (SIS) at American University created an integrated site and multiuse building that work together to produce a more sustainable environment for the university.

Solution: The site now works to recycle and filter all stormwater on the site. This is accomplished by collecting water from the building roof in a cistern for recycling to use in the building toilets. Stormwater detained on the site is reduced and filtered through green roofs, bioretention, and vegetated buffers. The building has also earned a LEED® Gold rating. Other sustainable features include xeriscape planting, edible plants, LED lighting, and no irrigation.

[7]Sustainable Sites Initiative. *The Sustainable Sites Initiative*. n.d. http://www.sustainablesites.org/certified-sites/americanuniversity (accessed 08.01.2014)

RELATED CODES AND REFERENCED STANDARDS

405.1.4.2.2.2 INFILTRATION RATES.

"For slopes areas where the methods provided in the referenced standards cannot be used successfully, alternate methods *approved* by the *code official* shall be permitted provide that the same method is used to test both reference soil and onsite soil."

Currently there are no other approved test methods.

2013 District of Columbia Plumbing Code Supplement—Section 1115 Rainwater Collection and Distribution Systems

http://dcra.dc.gov/page/regulations-dcra

Stormwater Management and Soil Erosion and Sediment Control. District of Columbia, July 19, 2013.

http://ddoe.dc.gov/swregs

RESOURCES

Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69308/pb13298-code-of-practice-090910.pdf

District Department of the Environment

http://ddoe.dc.gov/

Maryland Native Plant Society, Washington, D.C. Chapter

http://www.mdflora.org/chapters/washingtondc/dcchapter.html

Mid-Atlantic Invasive Plant Council

http://www.maipc.org

Native and Drought Tolerant Landscaping: Metro DC Lawn and Garden Blog, Ladybird Johnson Wildflower Center

http://gardening.mwcog.org/p/beneficial-drought-tolerant-plants-for.html

National Park Service

http://www.nps.gov/index.htm

Soil Scientist Society of America

https://www.soils.org

United States Environmental Protection Agency: Stormwater Pollution Prevention Plans for Construction Activities

http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Pollution-Prevention-Plans-for-Construction-Activities.cfm

406 BUILDING SITE WASTE MANAGEMENT

KEY REQUIREMENTS

- ✓ At least 75% of land clearing debris and excavation soil must be diverted from the landfill, including rocks, trees, stumps, etc
- ✓ Effective destruction of invasive species on site
- ✓ Maintain receipts for all waste management activities
- ✓ Provide verification of the project's compliance if requested by DCRA

TIMING IN CONSTRUCTION PROCESS

DESIGN	Develop site waste management plan to divert 75% of land clearing debris and excavated soils. Determine if site is in a state or federal quarantine zone to include quarantine rules.
PERMITTING	Include any notes in plans regarding quarantine rules, and areas of cut and fill of soils.
INSPECTIONS	Review submittal documents and visually verify waste management practices.
CERTIFICATE OF OCCUPANCY	Provide tipping receipts and tracking spreadsheet for review by DCRA.
POST OCCUPANCY	Consider tracking all future site work waste and continuing to recycle or reuse site waste as appropriate.

RATIONALE, BENEFITS, AND INTENTIONS

The intent of this section is to preserve healthy soils and protect vegetation, as well as to restore and reuse lands damaged by environmental contamination, therefore conserving and fostering native habitats.

Diverting debris and excavated soils from the landfill and reusing materials can reduce the cost of waste disposal for the project, reducing the need to purchase new landscaping materials. Trees can be preserved as part of the site planning process. Other debris such as stumps, brush, and other wood products, may be chipped or turned into wood mulches. Where possible, excavated soils can be stored on site and used as part of the landscaping.

BEST PRACTICES AND INNOVATION

At a minimum, develop a Building Site Waste Management Plan to follow throughout the construction process. This plan should detail:

- Specified diverted materials

- Appropriate locations for specified materials
- How contaminated soils will be removed, treated, and disposed of
- The amount of material to be diverted and the selected method for this calculation, weight OR volume.

RELATED CODES AND REFERENCED STANDARDS

406.3 VERIFICATION.

"Prior to issuance of the first certificate of occupancy, the *Department* is authorized to require the *owner*, contractor or an *approved agency* to provide verification of the project's compliance with the Section 406.1."

Currently there are no other approved agencies.

RESOURCES

Waste Management at the Construction Site

http://www.human.cornell.edu/dea/outreach/upload/Waste_Management-booklet.pdf

Whole Building Design Guide

http://www.wbdg.org/tools/cwm.php

407 TRANSPORTATION IMPACTS

Intentionally Blank. The District's Green Construction Code Supplement of 2013 deleted this section.

RELATED CODES AND REFERENCED STANDARDS

Refer to Appendix A for project electives related to this section.

408 HEAT ISLAND MITIGATION

KEY REQUIREMENTS

- ✓ The exposure of at least 50% of all hardscape[8]—defined as areas of the building site covered by man-made materials—must be mitigated by one of four options:
  - use of hardscape materials with solar reflectance at least 0.30
  - shade with structures
  - shade with trees
  - use of pervious and permeable pavements

TIMING IN CONSTRUCTION PROCESS

DESIGN

408.2 Determine total area of site hardscape. Determine at least one method to meet at least 50% of site hardscape requirements:

408.2.1 Determine materials that will work within the scope, goals and budget of the project that will meet a solar reflectance value of at least 0.3, are pervious or permeable concrete, or concrete without added color or stain.

408.2.2 Calculate areas of site shaded by structures on June 21st at noon. Determine if those areas are suitable for hardscape areas based on design considerations. Consider inclusion of open trellis type structures with native plantings to cover hardscape areas within the scope, goals and budget of the project.

408.2.3 Determine if and where the placement of trees to provide hardscape shading fits within the scope, goals and budget of the project. Consider implications on other regulations including the Green Area Ratio and Stormwater Regulations.

408.2.4 Determine if the placement of permeable and pervious pavement fits within the scope, goals and budget of the project. Consider implications on other regulations including the Green Area Ratio and Stormwater Regulations. Identify areas that are not suitable for permeable paving including fire and emergency apparatus or vehicle or personnel access and egress, utilities, or telecommunications lines.

[8] Site hardscape does not include areas of the site covered by solar photovoltaic arrays or solar thermal collectors.

PERMITTING	408.2 Include total area of hardscape and calculation of areas up to a minimum of 50% in compliance with this section: 408.2.1 Indicate hardscape areas on plan that will have a reflectivity of at least 0.3, are pervious or permeable concrete, or concrete without added color or stain. 408.2.2 Provide site plan with shading diagram and calculation of areas shaded by adjacent structures. Include on site plan open trellis type structures to be used, with construction details for structures and plant specifications to be native and achieve mature coverage within five years. 408.2.3 Provide landscape plan that show the planting location and the anticipated ten year canopy growth of new trees, and contribution of existing trees. Show calculations for areas shaded by trees. 408.2.4 Provide landscape plan that shows the locations of permeable and pervious pavements and types. Include detail sections. Show calculations for areas of pervious and permeable pavement.
INSPECTIONS	Visually verify shading components and materials as indicated in plans.
CERTIFICATE OF OCCUPANCY	===
POST OCCUPANCY	Many elements of the project's heat island mitigation design need continued maintenance to perform at their peak. Ensure proper maintenance schedules are completed to maintain all elements of the project including: reflectivity or porosity of installed hardscape; plantings on open trellis structures; trees; percolation rate of pavement.

RATIONALE, BENEFITS, AND INTENTIONS

Heat islands are dense areas where natural land cover has been replaced with pavement, buildings, and other infrastructure, characterized by distinct areas of air and surface temperatures that are higher than nearby surrounding areas. Studies have documented that urban areas have air and surface temperatures that are, on average, 1.8 – 5.4°F higher than temperatures in surrounding rural areas, and that there is the potential for up to a 22°F difference in more extreme situations.[9] This overheating leads to increased cooling loads and associated electrical consumption, contributing to greenhouse gas and pollution. It can also create overheated microclimates within the city, negatively impacting vegetation and wildlife.

[9] United States Environmental Protection Agency. *Urban Heat Island Mitigation | Heat Island Effect* | US EPA. n.d. http://www.epa.gov/hiri/mitigation/index.htm (accessed 07, 30, 2013).

The shade of lush tree canopies, extensive green spaces and tree lined boulevards are part of the District's heritage. In 1950 it was estimated that the District enjoyed a 50% tree canopy; DC's canopy in 2011 had declined to just over 35%[10].

The benefits of tree planting and other mitigation are broad. Vegetation and "cool pavements" can reduce heating and cooling energy use and associated air pollution and greenhouse gas emissions; remove air pollutants; sequester and store carbon; help lower the risk of heat-related illnesses and deaths; improve storm water control and water quality; reduce noise levels; create habitats; as well as improving aesthetic qualities and increase property values[11]. By providing permanent and seasonal shading, these heat islands can be avoided in the summer months, when they prove problematic. In the winter, urban areas may benefit from loss of seasonal shading and the resulting heat islands, which can reduce heating demands and potentially melt ice and snow.

BEST PRACTICES AND INNOVATIONS

Cool Pavement: The Solar Reflective Index (SRI) measures reflectivity. Darker materials typically have a lower reflectivity and thus a lower SRI. The use of concrete with higher albedo (greater reflectivity) and open grid systems can increase permeability and contribute to both air cooling and storm water processing. Research shows that for every 10-25% increase in albedo, surface temperatures can drop by up to one degree. Typical new white and grey concretes have SRIs of 85 and 35 respectively, compared to the SRI of 0 attributed to new asphalt.

Maximize the mitigation by using a combination of materials with solar reflectance $\leq$ 0.30, shading pervious and permeable materials to mitigate at least 75% of the hardscape. Additional heat island mitigation may be eligible for electives in Appendix A, Section A104.9.1.

Cool Roofs: Like pavement and hardscape, roof materials can also create unnecessary heat islands. The use of designated "cool roof" materials with a reflectance, emmittance, or SRI as designated in the table below serve to mitigate heat island impacts. Use products tested for a minimum three-year aged solar reflectance in accordance with ASTM E 1918, ASTM C 1549 or the CRRC-1 Standard and thermal emmittance in accordance with ASTM C 1371, ASTM E 408 or the CRRC-1 Standard, or labeled with an SRI determined in accordance with ASTM e 1980.

COOL ROOF REFLECTANCE AND EMMITTANCE[12]

Roof Slope	Minimum Aged Solar Reflectance	Minimal Thermal Emmittance	Minimum Aged SRI
2:12 or less	0.55	0.75	60
Greater than 2:12	0.30	0.75	25

[10] The Casey Foundation, http://caseytrees.org/about/mission/ (accessed August, 2013)

[11] United States Environmental Protection Agency. *Urban Heat Island Mitigation | Heat Island Effect* | US EPA. n.d. http://www.epa.gov/hiri/mitigation/index.htm (accessed 07, 30, 2013).

[12] International Code Council, Inc. *2012 IGCC: Code and Commentary.* International Code Council, Inc., 2012.

CASE STUDY

WASHINGTON, DC: CASEY TREES BROOKLAND OFFICES[13]

Image http://caseytrees.org/about/headquarters/bioretention/

Context: The Casey Trees Brookland Headquarters building not only houses the office operations, but also serves as a model for small-scale Low Impact Development using trees planted in bio-infiltration planters to control all the stormwater generated from the site along with a bioretention planter, three green roofs and a white roof.

Project Description: The bioretention planter is 1,700 square feet and created to capture up to five inches of rain in a storm. Bioretention planters are depressions filled with soil designed to capture stormwater runoff from roads, parking lots, roofs and other surfaces. They not only filter and temporarily store water which reduces flooding – they also create favorable growing conditions for trees planted within thereby improving the site's environmental and aesthetic characteristics.

Our headquarters' green roofs use two soil depths: 4 and 6 inches. The 6-inch soil base captures more rainfall and allows greater root development of the plants it supports. Atop that soil are three types of vegetated surfaces:

1. Traditional, which uses sedum planted directly into the soil base
2. Trays made up of pre-grown sedum
3. Pre-vegetated, sod-like rolls of sedum

Unlike traditional black roof surfaces, the cool roof is a white rubber membrane that reflects the sun's heat instead of absorbing it. Cool roofs can reduce roof surface temperatures by up to 100 degrees Fahrenheit, thereby reducing the heat transferred into the building below.

Results: These green features qualified the Casey Trees headquarters to participate in the Sustainable Sites Initiative (SITES) Pilot Program.

New construction techniques for cool pavement include[14]:

- Modifying the mix of asphalt and concrete to increase their reflective properties
- Using permeable pavements, such as a graded, bound mix of larger aggregate on a layer of crushed stone
- Vegetated pavements (planted grasses growing through and on a lattice installed on the ground)

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[13]The Casey Foundation, http://caseytrees.org/about/mission/ (accessed August, 2013)

[14] Kendra K. Levine, Institute of Transportation Studies Library at UC Berkeley. *Cool Pavements Research and Technology.* Investigation, Berkley: Caltrans Division of Research and Innovation, 2011.

Trees and Vegetation: Work with landscape designers to select native species that will provide shade on the east and west elevations:[15] planting a seasonal mix of deciduous trees to increase plant cover can reduce a building's cooling energy consumption by up to 25% .

Vegetated/Green roofs – Design the building to utilize vegetated roofing on at least 25% of roof area. Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air. Research indicates that on hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F (50°C) warmer.[16] This provides relatively pre-cooled air for rooftop HVAC systems, reducing the energy required for cooling the air. Although installation of a green roof usually involves higher upfront costs than a traditional roof, there are many economic benefits that can make up for this expense:

- Increased rooftop insulation and reduced rooftop temperatures lessen HVAC loads, resulting in energy cost savings.
- Vegetated roofs can lead to increases in property values and marketability, especially in urban areas with little green space.
- The use of vegetated roofs can lead to improved stormwater retention and filtration because the growing medium and plant material of the roof also act as a filter that helps to neutralize acid rain and trap dust and airborne particles.

[15] *US Environmental Protection Agency.* n.d. http://www.epa.gov/statelocalclimate/local/topics/heat-islands.html (accessed July 30, 2013).
[16] Liu, K. and B. Baskaran. 2003. Thermal Performance of Green Roofs through Field Evaluation. http://archive.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc46412/nrcc46412.pdf (accessed 2013)

CASE STUDY
NATIONAL PARK SERVICE RESEARCH

Image http://www.nps.gov/tps/images/mib-roof-yellow.jpg

Context: Studies have been completed by the University of Michigan and Penn State University exploring the impacts and benefits of green roofs. Along with other energy and stormwater benefits, green roofs contribute to a lower heat island effect and by doing so also add to the energy efficiency of buildings as described below.

Reduces Urban Heat Island Effect and Improves Air Quality: The temperature in cities is often higher than surrounding rural areas, a phenomenon known as the urban heat island effect. Large amounts of paved surfaces in cities absorb solar radiation and re–radiate it as heat, which increases the local air temperature. Green roofs not only help reduce the urban heat island effect by covering conventional dark roofing surfaces with vegetation which absorbs less heat, but they also use solar radiation to evaporate water from the growing media and transpire (the absorption of water through a plants roots and release of it through its leaves as a vapor) moisture from the plants. This process of evapotranspiration lowers the temperature on the roof by using heat from the air to evaporate water.[17]

Insulates the Building: A dark, heat–absorbing roof surface increases demands on mechanical systems, making it more difficult to adequately cool a building, whereas a green roof reduces the temperature of the roof and, therefore, the building itself. The extra layers of a green roof also serve as insulation. This decreases the amount of heat passing into the building, reduces cooling loads, and offers some insulation during the heating season, although, it is important to note, it does not replace the need for additional thermal insulation.

Improves Efficiency of Mechanical Equipment: Cooler roof temperatures produced by a green roof help boost the efficiency of rooftop mechanical equipment by making the air on the roof cooler. When in cooling mode, HVAC equipment must pre–cool outside air to get it to the required temperature. If the air on the roof is made cooler by a green roof, this process is easier and uses less energy. Therefore, lower air temperatures on the roof improve the efficiency of heat–rejecting rooftop HVAC equipment because it is operating at a lower ambient temperature.

[17]National Park Service, Technical Preservation Services. *Green Roof Benefits.* n.d. http://www.nps.gov/tps/sustainability/new-technology/green-roofs/benefits.htm.

RESOURCES

Casey Trees

http://caseytrees.org/

District Urban Forestry

https://www.mwcog.org/environment/forestry/

The Heat Island Effect: Cooling Strategies

http://www.austintexas.gov/coolspaces

Reducing Urban Heat Islands: Compendium of Strategies

http://www.epa.gov/hiri/resources/compendium.htm

Reducing Urban Heat Islands: Compendium of Strategies Cool Pavements

http://www.epa.gov/heatisland/resources/pdf/CoolPavesCompendium.pdf

Assessing the Health Impacts of Urban Heat Island Reduction Strategies in the District of Columbia

http://www.coolrooftoolkit.org/wp-content/uploads/2013/10/DC-Heat-Mortality-Study-for-DDOE-FINAL.pdf

409 SITE LIGHTING

KEY REQUIREMENTS

- ✓ Define lighting zone for building site
- ✓ Limit uplighting
- ✓ Limit backlighting and all other glare

TIMING IN CONSTRUCTION PROCESS

DESIGN	Determine which exterior lighting is required to comply with uplight, trespass and glare restrictions.
PERMITTING	In electrical lighting schedule, provide a separate column with uplight (U#), backlight (B#), and glare ratings (G#) where applicable. Specify height of mounting as applicable.
INSPECTIONS	Visually verify lighting matches plans.
CERTIFICATE OF OCCUPANCY	===
POST OCCUPANCY	===

RATIONALE, BENEFITS, AND INTENTIONS

The intent of this section is to mitigate the negative impacts of light pollution, resulting in energy savings, potential health benefits, and the ability to see and appreciate the night sky. As a broadly defined term, light pollution can refer to the problem of misdirected light, excess unwanted light, and the collective level of light above the city that creates a "sky glow", and excessive or distracting glare and brightness. Today, a typical suburban sky is about 5 to 10 times brighter at the zenith than the natural sky. In city centers, the zenith may be 25 or 50 times brighter than the natural background.[18]

Average lighting systems installed prior to 1995 are estimated to waste 30% of their output. Adjusting lighting levels and directionality can decrease energy use, and has additional positive impacts. High levels of lighting have been linked indirectly to increased risk of specific cancers, as over-exposure to light during sleep impedes the production and maintenance of the key hormones melatonin and estrogen in the body. Light trespass levels that disrupt sleep are linked to a deterioration of the immune system and, when used for negative effects, are listed by

[18] Sky and Telescope. n.d. http://www.skyandtelescope.com/ (accessed 07, 30, 2013).

Amnesty International as a method of torture[19].

Table 409.1 Exterior Lighting Zones	
1	Developed areas of national parks, state parks, forest land and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas.
3	All other areas
4	High-activity commercial districts

Glare can impede night vision, create driving hazards, and contributes to skyglow. Skyglow is literally the glowing sky over urban areas that does not dissipate. In certain weather conditions, such as rain, wind, and high pollution, it is difficult for astronomers to see anything but the most luminous stars and planets. Adverse behavioral effects have been recorded in many species of animals, such as sea turtles and birds that rely on the night sky for breeding and navigational purposes.[20]

BEST PRACTICES AND INNOVATIONS

Implementation of night sky sensitive lighting standards is considered best practice in the lighting and building industry, and is based on recommendations of the International Dark Sky Association.

Additionally the Dark Sky Society offers specific guidance in developing an exterior lighting plan[21]:

1. Identify where and when lighting is needed and work to restrict lighting to the extent necessary to meet safety requirements.
2. Direct light downward by choosing the correct type of light fixtures, either full cut off or fully shielded fixtures, so that no light is emitted above the lowest light emitting part of the fixture.
3. Select the correct bulb type.
4. Utilize shut off controls such as sensors, timers, motion detectors, etc. to turn off lights when not needed, including no later than one half hour after the close of business.
5. Limit the height of fixtures. Locate fixtures no closer to the property line than four times the mounting height of the fixture, and not to exceed the height of adjacent structures.
6. Limit light to spill across the property lines.
7. Use the correct amount of light. Light levels and uniformity ratios should not exceed recommended values, per IESNA RP-33 or 20.
8. For large projects greater energy conservation and control of light pollution, light trespass and glare, may be achieved with the help of a professional lighting designer with "dark sky" lighting plan experience.
9. Design interior lighting so that it does not illuminate the outdoors.

[19] Sky and Telescope. n.d. http://www.skyandtelescope.com/ (accessed 07, 30, 2013).
[20] Turning Night into Day: The Facts about Light Pollution. n.d. http://osr.org/articles/the-facts-about-light-pollution/ (accessed July 30, 2013).
[21] Dark Sky Society, *Lighting Plan Guidelines* http://www.darkskysociety.org/handouts/LightingPlanGuidelines.pdf. (accessed September, 2013)

RESOURCES

Dark Sky Society

http://www.darkskysociety.org/handouts/LightingPlanGuidelines.pdf

Light Pollution Facts and Solutions—Astronomical Society of Las Cruces

http://aslc-nm.org/Lighting.html

Lighting Applications and Design—Illuminating Engineering Society

http://www.ies.org/lighting/applications/exterior-structures.cfm

Lighting Applications and Design —International Association of Lighting Designers

http://www.iald.org/

National Lighting Product Information Program

http://www.lrc.rpi.edu/nlpip/